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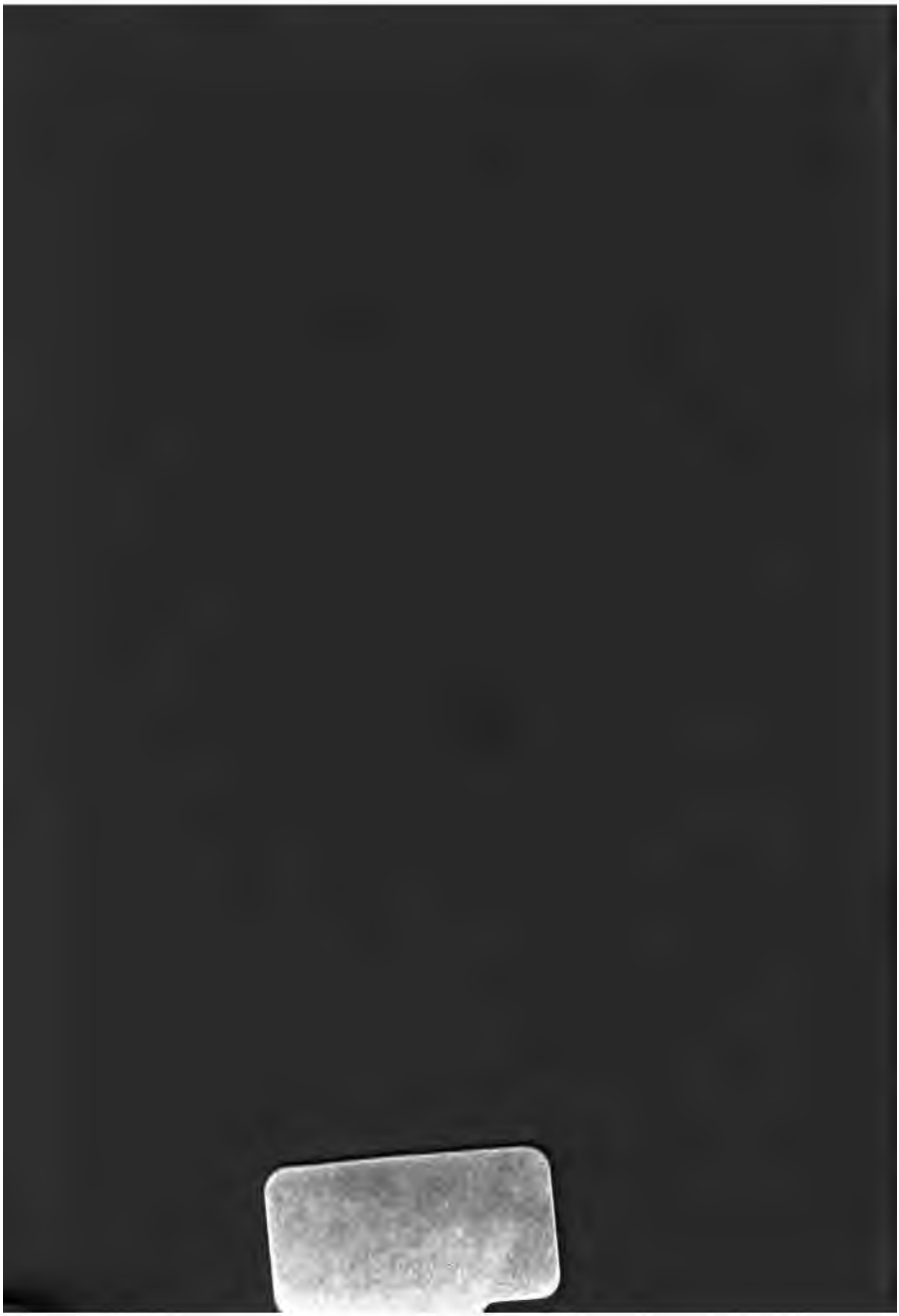
TABLES
FOR
PLATELAYERS

W. DONALDSON.



TABLES FOR PLATELAYERS,

COMPILED FROM THE FORMULÆ IN THE WORK ON

SWITCHES AND CROSSINGS.

BY

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EXPLANATION OF THE TABLES.

In the following Tables, the symbols c_1^2, c_1^3, c_1^4, c_2^3, c_2^4, c_3^4, &c., do not denote the circular measures of the angles of the crossings, as in the formulæ in the work on 'Switches and Crossings,' from which these Tables have been formed, but the actual leads of the crossings. That is to say, they give the length of a crossing in feet, the width of which at the open end is one foot between the centre lines of the rails. Thus the numbers 6, $6\frac{1}{2}$, 7, &c., in the Tables mean that the crossings are respectively 1 in 6, 1 in $6\frac{1}{2}$, 1 in 7, &c.

Since a figure is given for each particular case, it is not necessary to explain further the meaning of the symbols c_1^2, c_1^3, c_1^4, c_2^3, c_2^4, c_3^4, &c., than to state that each is placed at the particular crossing to which it refers. The letters H_1, H_2, H_3, H_4, H'_1, H'_2, H'_3, H'_4, &c., are either at the actual heels of the switches, or at the points where a line, through one set of heels at right angles to the main roads, cuts the rest of the main-road rail.

By main roads are meant not only the roads of the main line, but any road or roads in a goods yard, the position of which is fixed and from which or between which the siding roads, the position of which relatively to these is given in the Tables, lead or form a communication.

The point of the crossing referred to in the following Tables is not the actual point of the crossing, but the point where the centre lines of the rails which compose the crossing intersect, if it consist of two of the ordinary rails meeting at the proper angle. In Fig. 6, Plate I., the two dotted lines are the centre lines of the two rails, and the point c where they intersect is the one whose position is given by the

Tables. If the line of the inner edge of either rail be produced till it meets the outer edge of the other in c or c', either of these points will be at the same distance as c from the heel of the switch.

If the crossing be a solid box, lines must be marked on it parallel to each face of the V, at a distance from the face equal to half the thickness of the rail. The point where these lines intersect is the point required.

Thus the position of the point c can be readily marked on the crossing by means of a straight-edge or string.

The same crossing or set of crossings will suit several curves. The easier the crossing, the wider the range of curves it will suit. The distances, however, are correct only for that particular curve in the case of a curve leaving a straight line, or for those particular combinations of curves in the case of a curve leaving a curve where the rail of the siding road cuts the rail of the main road at an angle for which the value of c_1^2 given in the Tables is the exact lead of the crossing. The two following examples are given in the case of a curve leaving a straight line, gauge 4 ft. 8½ in. for the sake of illustration. The set of crossings, for which $c_1^2 = 8$, will suit all curves from 9 to 10½ chains radius, but the distances only the curve of 9·7 chains radius.

Similarly the set of crossings, for which $c_1^2 = 16$, will suit all curves from 36 to 41 chains radius, but the distances only the curve of 38·6 chains radius.

The relations between the leads of the crossings, and their distances from the heels of the switches hold true whether the main line is straight or curved. In the accompanying figures the main line is, for simplicity's sake, in every case drawn straight.

The figures in the Tables express so many lineal feet.

The foregoing remarks apply to every case given in the Tables. It is necessary besides to explain each case sepa-

Junctions. Single Gauge.

These must be divided into two classes.

I. Main-line junctions, where the centre lines of both roads are marked out.

II. Siding roads, leading from the up or down road across the down or up road, or from the down or up road directly into the station yard.

Class I.

Since the centre lines of both roads are staked out, whether the junction be that of a single line with a single line, or of a double or single line with a double line, the positions of the crossings are already fixed on the ground. In order to ascertain the leads of the crossings, the platelayer may either actually measure on the ground the lead of the crossing c_1^2, or he may make use of the formulæ given in the Table. The value of c_1^2 having been found, the Table will give the lead of the rest of the crossings and the distance of the heels of the switches from c_1^2. In putting in a set of junction roads, the platelayer must pay no attention to the springing of the curve, which is in all cases at a much greater distance from the heels of the switches than the length of the switches.

Class II.

When new station yards are first put in, definite plans are of course provided, showing the position of each siding. For subsequent alterations plans are not in all cases necessary, and therefore not always provided.

For instance, if a siding parallel to the main line has to be put in, the only special instructions which the foreman platelayer will require are the length of the siding and the point where it must leave the main line. If the siding is not parallel to the main line, he must know the length and the

position of the centre line of the siding. In neither case is a plan always necessary. He must use the Table in the following way:—

1st. Main Line Double.

When the siding road is parallel to the main line, unless the positions of the points of the switches as well as of the crossing are fixed, the platelayer may in this case use any set of crossings he likes, provided they are not sharper than those at which the main-line rails would be cut by the sharpest curve which the gauge admits of. Since the point where the siding leaves the main line is fixed, the position of c_1^4 is fixed also, and the position of the line of the heels of the switches must be marked on the main-line rails by means of the distance $H_4\, c_1^4$ given in the Tables, and the positions of the rest of the crossings by measuring from this line their distances given in the Table.

When the siding road is not parallel to the main line, the platelayer must measure on the ground the lead of the crossing of the last rail of the main line by the centre line of the siding. He must then find out in the column marked c the nearest lead to the observed lead. The set of crossings in the Table opposite to that value of c will be those belonging to a curve, the centre line of which will meet tangentially the centre line of the siding at the point where the centre line of the siding cuts the last rail of the main line. By means of the distance given in the column $H_4\, c$, opposite the observed value of c, mark on the main-line rails the line of the heels of the switches, and from this line measure off on the rails the positions of the crossings by means of the distances given in the Tables.

2nd. Main Line Single.

When the siding road is parallel to the main line, after the platelayer has chosen the lead of the crossing, he will

find the distance of the crossing from the heel of the switch in the column $H_2 c_1^2$, opposite the lead chosen in the column c_1^2.

When the siding road is not parallel to the main-line road, the platelayer must ascertain by measurement on the ground the lead of the crossing, which will correspond with the leads given in the column $c_1^2 = c_3^4$ in the Table. The distance in the column $H_2 c_1^2$ opposite the lead ascertained by measurement on the ground will give the position of the heel of the switches.

Three Throws. Single Gauge.

The Table for three throws requires no explanation. The knowledge that the point of the crossing c_m is in all cases exactly in the middle of the main road when the branch roads curve in opposite directions may assist the platelayer in putting in the three throw.

Cross-over Roads. Single Gauge.

When the lead of the crossing is known, the Table gives the interval in feet between the heels of the switches, and also the distance of each crossing from the heel of the switch belonging to it. When the total interval between the heels of the switches is known, the interval nearest to it in the Tables will give the proper leads of the crossings, but not the correct distances of each crossing from the heel of the switch.

In the beginning of the preface it was shown that every crossing will suit several curves, but that the distances will suit only one curve. The formulæ in Division II., Chap. V., of the work on 'Switches and Crossings,' show that the lead of the crossing is equal to the interval between the heels of the switches divided by a constant which depends upon the gauge and the interval between two contiguous roads, and that the distance from the crossing to the heel of the switch

is equal to the *exact value* of the lead of the crossing multiplied by a constant which depends upon the gauge. Now, although the Table gives the lead of all crossings which are required in practice to put in cross-over roads whose reverse curves lie between the extreme limits given in the Table, it gives only the distances corresponding to the exact value of the lead. If, therefore, the given interval lie between two intervals given in the Table, and the larger interval cannot be used, the platelayer must use the interval in the Table next less than the given interval.

For example. It is required to put in a cross-over road 4 ft. $8\frac{1}{2}$ in. gauge, between a road leading over a wash-out pit and a road into an engine-shed, the distance between the end of the wash-out pit and the door of the engine-shed being 156 ft. and the length of the switches 12 ft.

Deducting twice the length of the switches from the total distance, the interval between the heels of the switches = 156 — 24 ft. = 132 ft. This lies between the intervals 124 ft. and 140 ft. given in the Tables; we cannot in this case use the larger interval, and must therefore adopt the less, *viz.* 124 ft.

Through Roads. Single Gauge.

When the lead of the crossing c_1^8 is known, the Table gives the leads of the others, the total interval between the heels of the switches and the positions of the crossings. The same remarks apply to through roads as to cross-over roads, when the greatest interval between the points of the switches is known.

Junctions. Double Gauge.

The Table for double-gauge junctions must be used in the same way as the Table for single-gauge junctions. The letters c, c' refer to the crossings of the last main-line rail by the centre lines of the narrow and broad-gauge siding roads. c to the narrow, c' to the broad.

Three Throws. Double Gauge.

As in the case of single-gauge roads, when the branch roads turn in opposite directions, the crossings c_g^g, c_g^{g-d}, c_g^d are in the middle of the broad-gauge road, of the narrow-gauge road, and of the space between the two gauges respectively, whether the main line be straight or curved. When the branch roads turn in the same direction as the main line, there will be two cases, *viz.* one in which the branch roads leave the rail common to both gauges, Fig. 3, Plate II., and the other in which they cut the rail common to both gauges, Fig. 4, Plate II.

Only one Table is given, because the leads of the crossings in the one case are equal to the leads of the crossings of the corresponding pairs of rails in the other, and also the distances of corresponding crossings from the heels of the switches. It is, however, necessary to give two figures, because in the one case the crossings $c_{r\,1}^{d}\,c_{r\,2}^{d}$ are situated on the third rail of the main line, and in the other on the second, and the crossings $c_{r\,1}^{g-d}$, $c_{r\,2}^{g-d}$ are situated in the one on the second, and in the other on the third rail. The Table suits Fig. 3, so that the distances $H_2\,c_{r\,1}^{d}$, $H_2\,c_{r\,2}^{d}$ in Fig. 4 will correspond with the distances $H_3\,c_{r\,1}^{d}$, $H_3\,c_{r\,2}^{d}$ respectively in the Table, and the distance $H_3\,c_{r\,1}^{g-d}$, $H_3\,c_{r\,2}^{g-d}$ in Fig. 4, with the distances $H_2\,c_{r\,1}^{g-d}$, $H_2\,c_{r\,2}^{g-d}$ respectively, and so on for c_g^d and c_g^{g-d}.

Cross-over Roads. Double Gauge.

The two cases for single-gauge cross-overs, when the four main-line roads have a common centre line, and the case of the double-gauge cross-over, when the four main-line roads have not a common centre line, need no further explanations than those given already for single-gauge roads.

The double-gauge cross-over, when the main lines have a common centre line, is very complicated; with the aid of the figure the Table is, however, very plain and easy to be understood.

The columns under the letters A, B, C, *a*, *b*, *c*, refer to the narrow-gauge rail, which starts from the broad-gauge main-line rail, common to both gauges. The positions of the heels of the switches of the broad-gauge rails and of the narrow-gauge rail, which is not common to both gauges, are fixed by the interval between the heels of the switches given in the Table, and the position of the fast point or of the heel of the switch of the other narrow-gauge rail is determined by its distance from heel of the switch of the broad-gauge rail given in the Table. When the main line is straight, or the radius of the curve greater than 100 chains, the radii of the reverse curves are in one case exactly, and in the other practically, equal; but when the radius of the main line is less than 100 chains, the radii of the reverse curves are sensibly different, and the difference between them increases very rapidly as the radius of the main line decreases. It is therefore necessary to give two Tables, *viz.* one which gives the leads of the crossings and their position and the corresponding values of A, B, C, when the main line is straight, and another which gives the values of A, B, C, *a*, *b*, *c*, corresponding to different combinations of main line and reverse curves and the lead of b_1^s which suits the combination. When the main line is straight, one Table suffices, because there is only one set of values of A, B, C, which exactly correspond with each particular lead of crossing; but when the main line is curved the same crossing will suit several combinations of curves, and therefore a second Table is necessary.

In the Table for curved main lines, the column headed value of *r* gives the least and greatest values of the radius of the sharpest reverse curve corresponding to the least and

greatest values of the radius of the main-line curve opposite to them in the column headed value of R. For intermediate values of the radius of the main-line curve, the value of the radius of the sharpest reverse curve will also lie between the extreme values given in the Table. Under the column b_1^s in the Table for curved main lines will be found the lead of the crossing b_1^s, which corresponds to the set of values of A, B, C, a, b, c selected, and in the adjoining Table opposite the value of b_1^s thus determined will be found the interval between the heels of the broad-gauge switches, the leads of the rest of the crossings, and the positions of all. The values of A, B, C, a, b, c in the Table for curved main lines are not exactly correct of course for every combination of R and r between the given limits, but the deviations from exactness in the extreme cases are practically of no consequence.

Cross-over roads of this kind may be put in between two roads, so long as the radius is not less than 12 chains; but as a separate calculation must be made for each case under 18 chains radius, and such a cross-over must be of rare occurrence, it is not worth while to make the Table of an inconvenient size for the sake of including them.

In single-gauge cross-overs the greatest value of the radius of the sharpest reverse curve is equal to half the radius of the main line, but in double-gauge cross-overs it cannot be made equal to this, for reasons given in the work on 'Switches and Crossings,' and ought in practice always to have its least admissible value, because the length of the splay of the fast point and the distance of the fast point and of the heel of the switch from the heel of the broad-gauge switch increases as r increases.

The Table for the 3 ft. 3 in. single gauge requires some special explanations. The interval between the centre lines of two adjoining roads on the main line is 10 ft., but in the station sidings the same interval is 11 ft. 6 in.; consequently it is necessary in the Table for cross-overs to give two

columns of intervals corresponding to these two cases, the leads of the crossings and their distances from the heels of the switches being the same in each case. In the case of through roads it is necessary to give two entirely distinct Tables, because not only the interval between the heels of the switches but the lead and position of every crossing, except those of c_1^2 and c_2^5, are different. In the case of the goods yard through road, the interval between the centre lines of each pair of adjacent roads is equal to 11 ft. 6 in., and in the case of the main line the same interval for each pair is 10 ft. only.

There is not space therefore in the Table itself for the following formulæ:

If R = radius of main line in chains.

r = „ branch „ „

$c_1^2 = 3{\cdot}1\sqrt{r}$ when the main line is straight.

$c_1^2 = 3{\cdot}1\sqrt{\frac{Rr}{R-r}}$ when the main line is curved and the branch line curves in the same direction.

$c_1^2 = 3{\cdot}1\sqrt{\frac{R}{R+r}}$ when the main line is curved and the branch line curves in the opposite direction.

Length of splay of fast point $= \frac{2}{5} \times c_1^2$ ft.

Distance of point of fast point from point of crossing .. $= 6 \times c_1^2$ ft.

A cross-over cannot be put in when the radius of the main line is less than 4 chains, or a through road when it is less than 4½ chains. The least and greatest values of c_1^2 for cross-over and through roads are:

$$\text{Least value} = 4{\cdot}4\sqrt{\frac{R}{R-2}}.$$

$$\text{Greatest value} = 3{\cdot}1\sqrt{R}.$$

The intervals between the centre lines of contiguous roads

and the least admissible radius in each case are, in addition to the gauge, the data necessary for forming the Tables, and have been assumed to be as follows :—

Gauge.		Interval between centre lines of contiguous roads.		Least radius.
ft.	in.	ft.	in.	chains.
4	$8\frac{1}{2}$	11	0	4
7	0	13	3	5
5	3	11	6	4
5	6	11	9	4
3	6	10	0	2
3	3	10 ft. and 11 ft.	6 in.	2
1	$11\frac{1}{2}$	7	$3\frac{1}{2}$	1

Fig. 1.

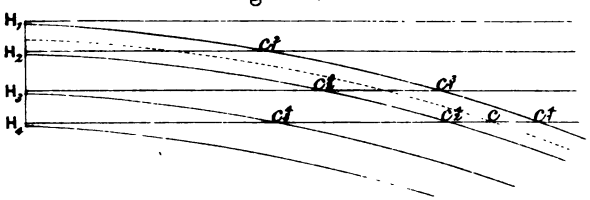


Fig. 2.

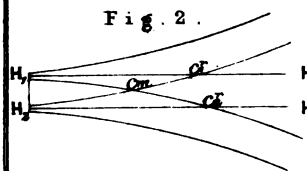


Fig. 3.

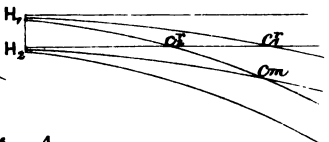


Fig. 4.

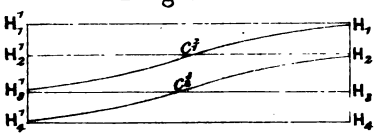


Fig. 5.

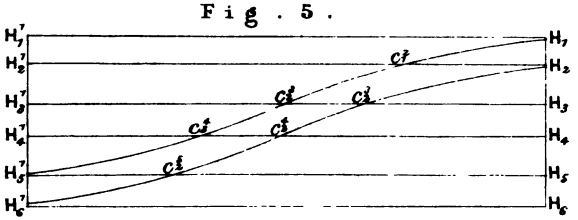
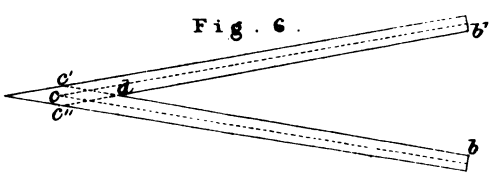


Fig. 6.



E. & F.N. Spon, 48, Charing Cross, London.

TABLE I.—4 FT. 8½ IN. GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 4⅛ inches.
Clearance at point of fast point = 2 "
Thickness of point of fast point = ⅛ inch.

JUNCTIONS.									
$c_1^2 = c_2^2$.	$c_1^2 = c_3^2$.	c_1^2.	c_2^2.	$H_2 c_1^2 = H_4 c_2^2$.	$H_2 c_1^2 = H_4 c_3^2$.	$H_4 c_1^2$.	$H_2 c_2^2$.	c.	$H_4 c$.
4	2½	2½	4	29	49	61	33	2½	55
4½	3	2½	4	33	55	68	37	2½	62
5	3½	3	4½	36	61	76	41	3	69
5½	4	3	5	40	67	83	45	3½	75
6	4	3½	5½	44	73	91	49	3½	82
6½	4½	4	6	47	79	99	53	4	89
7	5	4	6½	51	85	106	58	4½	96
7½	5	4½	7	55	91	114	62	4½	103
8	5½	4½	7½	58	97	121	66	5	110
9	6	5	8	65	109	136	74	5½	123
10	7	5½	9	73	121	152	82	6	137
11	7½	6	10	80	133	167	90	6½	151
12	8	7	11	87	145	182	99	7	164
13	9	7½	12	94	157	197	107	8	178
14	10	8	13	102	169	212	115	8	192
15	10	9	14	109	181	227	124	9	205
16	11	9	15	116	194	242	132	10	219

R = radius of main road in chains.
r = radius of branch road in chains.

$c_1^2 = 2{\cdot}6\sqrt{r}$ when the main line is straight.

$c_1^2 = 2{\cdot}6\sqrt{\frac{Rr}{R-r}}$ feet, when the main line is curved and the branch road curves in the same direction.

$c_1^2 = 2{\cdot}6\sqrt{\frac{Rr}{R+r}}$ feet, when the main line is curved and the branch roads curve in the opposite direction.

Length of splay of fast point = ¼ × c_1^2 feet.

Distance of point from point of crossing = 8 × c_1^2 feet.

A cross-over cannot be put in when the radius of the main line is less than 8 chains, or a through road when the radius is less than 9 chains. The greatest and least values of c_1^2 for cross-over and through roads are—

Least value = $5\sqrt{\frac{R}{R-4}}$.

Greatest value = $2{\cdot}6\sqrt{R}$.

THREE THROWS.								CROSS-OVER.			THROUGH ROADS.						
Branch Roads Curving in opposite Directions.				Branch Roads Curving in the same Direction.													
$c_{r_1} = c_{r_2}$.	c_m.	$H_1 c_{r_1} = H_2 c_{r_2}$.	$H_1 c_m = H_2 c_m$.	c_{r_2}.	$c_{r_1} = c_m$.	$H_2 c_{r_2}$.	$H_2 c_{r_1} = H_2 c_m$.	$c_1^2 = c_2^2$.	Interval between heels of Switches.	$H_2 c_1^2 = H'_2 c_2^2$.	$c_1^2 = c_2^2$.	$c_1^2 = c_3^2$.	$c_1^4 = c_2^2$.	Interval between heels of Switches.	$H_2 c_1^2 = H'_2 c_2^2$.	$H_2 c_1^2 = H'_4 c_2^4$.	$H_2 c_2^2 = H'_4 c_1^4$.
5	3½	36	22	5	7	31	51	5	78	36	5	3½	4½	122	36	61	41
5½	4	40	24	5½	8	34	56	5½	85	40	6	4	5	134	40	67	45
6	4½	44	26	6	8½	37	61	6	93	44	6½	4½	5½	146	44	73	49
6½	4½	47	28	6½	9	40	67	6½	101	47	7	5	6	158	47	79	53
7	5	51	30	7	10	43	72	7	109	51	7½	5	6½	170	51	85	58
7½	5½	55	33	7½	11	46	77	7½	116	55	8	5½	7	182	55	91	62
8	6	58	35	8	11	49	82	8	124	58	9	6	8	218	65	109	74
9	6½	65	39	9	13	55	92	9	140	65	10	7	9	242	73	121	82
10	7	73	43	10	14	61	102	10	155	73							

TABLE II.—7 FT. GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 4¼ inches.
Clearance at point of fast point = 2 „
Thickness at point of fast point = ⅛ inch.

JUNCTIONS. Fig. 1, Plate I.

$c_1^2 = c_2^2$.	$c_1^3 = c_2^3$.	c_1^4.	c_2^3.	$H_3 c_1^3 = H_4 c_2^4$.	$H_3 c_1^4 = H_4 c_2^4$.	$H_4 c_1^4$.	$H_3 c_2^3$.	c.	$H_4 c$.
3	2½	2	3½	34	49	63	30	2	56
3½	2½	2½	4	39	57	74	35	2½	66
4	3	2½	4½	45	65	84	40	2½	75
4½	3½	3	5	50	74	95	45	3	85
5	3½	3	5½	56	82	105	50	3½	94
5½	4	3½	6	62	90	116	54	3½	103
6	4½	3½	6½	67	98	126	59	4	113
6½	5	4	7½	73	106	137	64	4½	122
7	5	4	8	78	114	148	69	4½	132
7½	5½	4½	8	84	122	158	74	5	141
8	6	5	9	90	130	169	79	5½	150
9	6½	5½	10	101	147	190	89	6	169
10	7	6	11	112	163	211	99	6½	188
11	8	6½	12	123	179	232	109	7	207
12	9	7	13	134	196	253	119	7½	225
13	9	8	14	146	212	274	128	8	244
14	10	8	16	157	228	295	138	9	262

If R = radius of main line in chains.
r = „ branch „ „

$c_1^2 = 2{\cdot}1\sqrt{r}$ when main line is straight.

$c_1^2 = 2{\cdot}1\sqrt{\frac{Rr}{R-r}}$ when main line is curved and branch line curves in the same direction.

$c_1^2 = 2{\cdot}1\sqrt{\frac{Rr}{R+r}}$ when main line is curved and branch line curves in the opposite direction.

Length of splay of fast point . . . } $= \frac{8}{10} \times c_1^2$ ft.

Distance of point of fast point from point of crossing . } $= 12 \times c_1^2$ ft.

A cross-over cannot be put in when the radius of the main line is less than 10 chains, or a through road when the radius is less than 11 chains. The greatest and least values of c_1^2 for cross-over and through roads are—

Least value $= 4{\cdot}8\sqrt{\frac{R}{R-5}}$.

Greatest value $= 2{\cdot}1\sqrt{R}$.

THREE THROWS.

Branch Roads Curving in opposite Directions. Fig. 2, Plate I.

$c_{r_1} = c_{r_2}$.	c_m.	$H_1 c_{r_1} = H_2 c_{r_2}$.	$H_1 c_m = H_2 c_m$.
4½	3½	50	32
5	3½	56	35
5½	4	62	39
6	4½	67	42
6½	4½	73	46
7	5	78	49
7½	5½	84	53
8	6	90	56
9	6½	101	63

Branch Roads Curving in the same Direction. Fig. 3, Plate I.

c_{r_2}.	$c_{r_1} = c_m$.	$H_2 c_{r_2}$.	$H_2 c_{r_1} = H_2 c_m$.
4½	6½	44	71
5	7	49	79
5½	8	54	87
6	8	59	95
6½	9	64	103
7	10	69	111
7½	11	74	119
8	11	79	126
9	13	89	143

CROSS-OVER. Fig. 4, Plate I.

$c_1^2 = c_2^2$.	Interval between heels of Switches.	$H_2 c_1^2 = H_2^1 c_2^2$.
5	96	51
5½	106	56
6	115	61
6½	125	66
7	135	71
7½	144	77
8	154	82
9	173	92
10	192	102

THROUGH ROAD. Fig. 5, Plate I.

$c_1^2 = c_2^2$.	$c_1^3 = c_2^4$.	$c_2^3 = c_1^4$.	Interval between heels of Switches.	$H_2 c_1^3 = H_2^1 c_2^3$.	$H_2 c_1^3 = H_4 c_2^4$.	$H_2 c_2^3 = H_4 c_1^4$.
4½	3½	5	148	50	74	45
5	3½	5½	184	56	82	50
5½	4	6	180	62	90	54
6	4½	6½	196	67	98	59
6½	5	7½	212	73	106	64
7	5	8	228	78	114	69
7½	5½	8	244	84	122	74
8	6	9	260	90	130	79
9	6½	10	294	101	147	89

TABLE III.—5 FT. 3 IN. GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 4⅛ inches.
Clearance at point of fast point = 2 "
Thickness at point of fast point = ⅛ inch.

JUNCTIONS.									
$c_1^3 = c_2^4$.	$c_1^4 = c_2^5$.	c_1^4.	c_2^5.	$H_2 c_1^4 = H_1 c_2^5$.	$H_2 c_1^5 = H_1 c_2^6$.	$H_1 c_1^4$.	$H_2 c_2^5$.	c	$H_1 c$
4	2½	2½	4	33	52	66	35	2½	60
4½	3	2½	4½	37	59	74	39	2⅝	67
5	3½	3	5	41	65	82	43	3	74
5½	4	3½	5½	45	72	91	47	3½	82
6	4½	3½	6	49	78	99	52	3¾	89
6½	4½	4	6½	53	85	107	56	4	97
7	5	4	7	57	91	115	60	4½	104
7½	5½	4½	7½	61	98	124	65	4⅝	111
8	5½	4½	8	65	104	132	69	5	119
9	6½	5½	9	73	117	148	78	5½	133
10	7	6	10	81	130	165	86	6½	148
11	7½	6½	11	89	143	181	95	7	163
12	8	7	12	97	156	198	103	7½	178
13	9	7½	13	106	170	214	112	8	193
14	10	8	13	114	182	232	121	9	208
15	10	9	14	122	195	247	129	9	223
16	11	9	15	130	209	264	138	10	238

R = radius of main line in chains.
r = radius of branch line in chains.

$c_1^3 = 2{\cdot}5\sqrt{r}$ when the main line is straight.

$c_1^3 = 2{\cdot}5\sqrt{\frac{R\,r}{R-r}}$ when the main line is curved and the branch road curves in the opposite direction.

$c_1^3 = 2{\cdot}5\sqrt{\frac{R\,r}{R+r}}$ when the main line is curved and the branch road curves in the same direction.

Length of splay of fast point = ¼ × c_1^3 feet.

Distance of point from point of crossings = 9 × c_1^3 feet.

A cross-over cannot be put in when the radius of the main line is less than 8 chains, or a through road when the radius is less than 9 chains. The greatest and least values of c_1^3 for cross-over and through roads are—

Least value = $4{\cdot}9\sqrt{\frac{R}{R-4}}$.

Greatest value = $2{\cdot}5\sqrt{R}$.

THREE THROWS.								CROSS-OVER.			THROUGH ROADS.						
Branch Roads Curving in opposite Directions.				Branch Roads Curving in the same Direction.													
$c_{r_1} = c_{r_2}$.	c_m.	$H_1 c_{r_1} = H_2 c_{r_2}$.	$H_1 c_m = H_2 c_m$.	c_{r_2}.	$c_{r_1} = c_m$.	$H_2 c_{r_2}$.	$H_2 c_{r_1} = H_2 c_m$.	$c_1^3 = c_2^3$.	Interval between heels of Switches.	$H_2 c_1^3 = H'_2 c_2^3$.	$c_1^3 = c_2^4$.	$c_1^4 = c_2^5$.	$c_1^5 = c_2^6$.	Interval between heels of Switches.	$H_2 c_1^4 = H'_2 c_2^5$.	$H_2 c_1^5 = H'_4 c_2^6$.	$H_2 c_2^5 = H'_4 c_1^4$.
5	3½	41	25	5	7	35	57	5	84	41	5	3½	5	130	41	65	43
5½	4	45	27	5½	8	38	63	5½	92	45	5½	4	5½	143	45	72	47
6	4½	49	29	6	9	42	69	6	101	49	6	4½	6	156	49	78	52
6½	4½	53	32	6½	9	45	75	6½	109	53	6½	4½	6½	169	53	85	56
7	5	57	34	7	10	49	80	7	117	57	7	5	7	182	57	91	60
7½	5½	61	37	7½	11	52	86	7½	126	61	7½	5½	7½	195	61	98	65
8	6	65	39	8	11	56	92	8	134	65	8	5½	8	209	65	104	69
9	6½	73	44	9	13	63	103	9	151	73	9	6½	9	235	73	117	78
10	7	81	49	10	14	70	115	10	168	81	10	7	10	261	81	130	86

TABLE IV.—5 FT. 6 IN. GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 4¼ inches.
Clearance at point of fast point = 2 "
Thickness at point of fast point = ⅛ inch.

JUNCTIONS.

$c_1^2 = c_2^2$.	$c_1^2 = c_3^2$.	c_1^2.	c_2^2.	$H_2 c_1^2 = H_1 c_2^2$.	$H_2 c_1^2 = H_1 c_3^2$.	$H_1 c_1^2$.	$H_2 c_2^2$.	c	$H_2 c$.
4	3	2¼	4	34	54	69	35	2¼	62
4¼	3¼	2¼	4¼	39	61	77	40	3	69
5	3¼	2¾	5	43	68	86	44	3¼	77
5¼	4	3	5¼	47	74	94	49	3¼	85
6	4¼	3¼	6	51	81	103	53	3¾	92
6¼	4¼	3¼	6¼	56	88	111	57	4	100
7	5	4	7	60	95	120	62	4¼	108
7¼	5¼	4¼	7¼	64	101	129	66	4¾	115
8	6	4¼	8	69	108	137	71	5	123
9	6¼	5	9	77	122	154	79	5¼	139
10	7	5¼	10	86	135	171	88	6¼	154
11	8	6	11	94	149	188	97	7	169
12	9	7	12	103	162	206	106	7¼	185
13	9	7¼	13	111	176	223	115	8	200
14	10	8	14	120	189	240	123	9	215
15	11	9	15	128	203	257	132	10	231
16	11	9	16	137	216	274	141	10	246

R = radius of main line in chains.
r = radius of branch line in chains.

$c_1^2 = 2{\cdot}4\sqrt{r}$ when the main line is straight.

$c_1^2 = 2{\cdot}4\sqrt{\frac{Rr}{R-r}}$ when the branch road curves in the same direction.

$c_1^2 = 2{\cdot}4\sqrt{\frac{Rr}{R+r}}$ when the branch road curves in the opposite direction.

Length of splay of fast point = $\frac{5}{16} \times c_1^2$ feet.

Distance of point from point of crossing = $9\frac{1}{2} \times c_1^2$ feet.

A cross-over cannot be put in when the radius of the main line is less than 8 chains, or a through road when the radius is less than 10 chains. The greatest and least values of c_1^2 for cross-over and through roads are,

Least value = $4{\cdot}8\sqrt{\frac{R}{R-4}}$.

Greatest value = $2{\cdot}4\sqrt{R}$.

THREE THROWS.

Branch Roads Curving in opposite Directions.

$c_1 = c_2$.	c_m.	$H_1 c_1 = H_2 c_2$.	$H_1 c_m = H_2 c_m$.
5	3¼	43	26
5¼	4	47	29
6	4¼	51	31
6¼	4¼	56	34
7	5	60	37
7¼	5¼	64	39
	6	69	42
	¼	77	47
		86	52

Branch Roads Curving in the same Direction.

c_2.	$c_1 = c_m$.	$H_2 c_2$.	$H_2 c_1 = H_2 c_m$.
5	7	37	60
5¼	8	40	66
6	9	44	72
6¼	9	48	78
7	10	51	84
7¼	11	55	90
8	11	59	96
9	13	66	109
10	14	74	121

CROSS-OVER.

$c_1^2 = c_2^2$.	Interval between heels of Switches.	$H_2 c_1^2 = H'_2 c_2^2$.
5	87	43
5¼	96	47
6	104	51
6¼	113	56
7	122	60
7¼	130	64
8	139	69
9	156	77
10	174	86

THROUGH ROADS.

$c_1^2 = c_2^2$.	$c_1^2 = c'^2_2$.	$c_1^2 = c_2^2$.	Interval between heels of Switches.	$H_2 c_1^2 = H'_2 c_2^2$.	$H_2 c_1^2 = H'_4 c_2^2$.	$H_2 c_2^2 = H'_4 c_1^2$.
5	3¼	5	135	43	68	44
5¼	4	5¼	149	47	74	49
6	4¼	6	162	51	81	53
6¼	4¼	6¼	176	56	88	57
7	5	7	189	60	95	62
7¼	5¼	7¼	203	64	101	66
8	6	8	216	69	108	71
9	6¼	9	243	77	122	79
10	7	10	270	86	135	88

TABLE V.—3 FT. 6 IN. GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 3¼ inches.
Clearance at point of fast point = 2 "
Thickness at point of fast point = ¼ inch.

JUNCTIONS. Fig. 1, Plate I.

$c_1^2 = c_2^2$.	$c_1^2 = c_3^2$.	c_1^4.	c_2^2.	$H_2\, c_1^2 = H_4\, c_2^2$.	$H_3\, c_1^2 = H_4\, c_3^2$.	$H_4\, c_1^4$.	$H_3\, c_2^2$.	c.	$H_4\, c$.
4	2¼	2¼	3	21	40	48	30	2¼	44
4¼	2¼	2¼	3¼	23	45	54	34	2¼	50
5	3	2¼	4	26	50	60	38	2¼	55
5¼	3¼	3	4¼	28	55	66	41	3	61
6	4	3¼	4¼	31	60	72	45	3¼	66
6¼	4	3¼	5	34	65	78	49	3¼	72
7	4¼	4	5¼	36	70	84	53	3¼	77
7¼	4¼	4	6	39	75	90	56	4	83
8	5	4¼	6	42	80	96	60	4¼	88
9	5¼	5	7	47	90	108	68	5	99
10	6	5¼	7¼	52	100	120	75	5¼	110
11	7	6	8	57	110	132	83	6	121
12	7¼	6¼	9	62	120	144	90	6¼	132
13	8	7	10	67	130	156	98	7	143
14	9	7¼	11	73	140	168	105	7¼	154
15	9	8	11	78	150	180	113	8	165
16	10	8	12	83	160	192	120	9	176

If R = radius of main line in chains.
r = radius of branch line in chains.

$c_1^2 = 3\sqrt{r}$ when the main line is straight.

$c_1^2 = 3\sqrt{\frac{Rr}{R-r}}$ when the main line is curved and the branch line curves in the same direction.

$c_1^2 = 3\sqrt{\frac{Rr}{R+r}}$ when the main line is curved and the branch road curves in the opposite direction.

Length of fast point = ¼ × c_1^2 feet.

Distance of point from point of crossing = 5¼ × c_1^2 feet.

A cross-over cannot be put in where the radius of the main line is less than 4 chains, or a through road when it is less than 4¼ chains. The greatest and least values of c_1^2 for cross-over and through roads are—

Least value = $4{\cdot}2\sqrt{\frac{R}{R-2}}$.

Greatest value = $3\sqrt{R}$.

THREE THROWS.

Branch Roads Curving in opposite Directions. Fig. 2, Plate I.

$c_1 = c_2$.	c_m.	$H_1\, c_1 = H_2\, c_2$.	$H_1\, c_m = H_2\, c_m$.
4¼	3¼	23	14
5	3¼	26	15
5¼	4	28	17
6	4¼	31	18
6¼	4¼	34	20
7	5	36	21
7¼	5¼	39	23
8	6	42	24
9	6¼	47	27

Branch Roads Curving in the same Direction. Fig. 3, Plate I.

c_{r_2}.	$c_{r_1} = c_m$.	$H_2\, c_{r_2}$.	$H_2\, c_{r_1} = H_2\, c_m$.
4¼	6½	19	33
5	7	22	37
5¼	8	24	40
6	9	26	44
6¼	9	28	48
7	10	30	51
7¼	11	32	55
8	11	35	59
9	13	39	66

CROSS-OVER. Fig. 4, Plate I.

$c_1^2 = c_2^2$.	Interval between heels of Switches.	$H_2\, c_1^2 = H'_2\, c_2^2$.
4¼	58	23
5	64	26
5¼	71	28
6	77	31
6¼	84	34
7	90	36
7¼	96	39
8	103	42
9	116	47

THROUGH ROADS. Fig. 5, Plate I.

$c_1^2 = c_2^2$.	$c_1^2 = c_3^2$.	$c_1^4 = c_2^2$.	Interval between heels of Switches.	$H_2\, c_1^2 = H'_2\, c_2^2$.	$H_2\, c_1^2 = H'_4\, c_3^2$.	$H_2\, c_2^2 = H'_4\, c_1^4$.
4¼	2¼	3¼	90	23	45	34
5	3	4	100	26	50	38
5¼	3¼	4¼	110	28	55	41
6	4	4¼	120	31	60	45
6¼	4	5	130	34	65	49
7	4¼	5¼	140	36	70	53
7¼	4¼	6	150	39	75	56
8	5	6	160	42	80	60
9	5¼	7	180	47	90	68

TABLE VI.—3 FT. 3 IN. GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 3¼ inches.
Clearance of point at fast point = 2 "
Thickness of point of fast point = ⅛ inch.

JUNCTIONS. Fig. 1, Plate I.										THROUGH ROADS. MAIN LINE. Fig. 5, Plate I.						
$c_1^2 = c_2^1$.	$c_1^3 = c_2^2$.	c_1^4.	c_2^3.	$H_3\,c_1^3 = H_4\,c_2^4$.	$H_3\,c_1^4 = H_4\,c_2^5$.	$H_4\,c_1^5$.	$H_3\,c_2^3$.	c.	$H_4\,c$.	$c_1^2 = c_2^1$.	$c_1^3 = c_2^2$.	$c_1^4 = c_2^3$.	Interval between heels of Switches.	$H_3\,c_1^3 = H'_3\,c_2^4$.	$H_3\,c_1^4 = H'_4\,c_2^5$.	$H_3\,c_2^3 = H_4\,c_1^4$.
4	2¼	2	3	19	39	46	30	2¼	42	4¼	2¼	3¼	87	22	43	33
4¼	2½	2¼	3¼	22	43	52	33	2½	48	5	3	3¼	96	24	48	37
5	3	2½	3½	24	48	57	37	2¾	53	5¼	3¼	4	106	26	53	41
5¼	3¼	2¾	4	26	53	63	41	3	58	6	3½	4¼	116	29	58	45
6	3½	3	4¼	29	58	69	45	3¼	63	6¼	4	5	126	31	63	48
6¼	4	3¼	5	31	63	75	48	3½	69	7	4	5	135	33	67	52
7	4	3½	5	33	67	80	52	4	74	7¼	4¼	5¼	144	36	72	56
7¼	4¼	4	5¼	36	72	86	56	4	80	8	5	6	154	38	77	59
8	5	4	6	38	77	92	59	4¼	85	9	5¼	6¼	174	43	87	67
9	5¼	4¼	6¼	43	87	103	67	5	95							
10	6	5	7¼	48	96	115	74	5¼	106							
11	6¼	5¼	8	53	106	126	82	6	116							
12	7	6	9	57	115	138	89	6¼	127							
13	7¼	6¼	9	62	125	149	96	7	137	For values of c_1^2, &c., *see* the Preface.						
14	8	7	10	67	135	161	104	7¼	148							
15	9	7¼	11	72	144	172	111	8	158							
16	9	8	12	76	154	184	119	9	169							

THREE THROWS.						CROSS-OVER. Fig. 4, Plate I.				THROUGH ROADS. GOODS YARD. Fig. 5, Plate I.						
Branch Roads Curving in opposite Directions. Fig. 2, Plate I.				Branch Roads Curving in the same Direction. Fig. 3, Plate I.												
$cr_1 = cr_3$.	cm.	$H_1\,cr_1 = H_3\,cr_3$.	$H_1\,cm = H_3\,cm$.	cr_3.	$cr_1 = cm$.	$H_2\,cr_3$.	$H_3\,cr_1 = H_3\,cm$.	$c_1^2 = c_2^1$.	Interval between heels of Switches. Main line.	Interval between heels of Switches. Goods yards.	$H_3\,c_1^3 = H'_3\,c_2^3$.	$c_1^2 = c_2^1$.	$c_1^3 = c_2^2$.	$c_1^4 = c_2^3$.	Interval between heels of Switches.	$H_3\,c_1^3 = H'_3\,c_2^4$.	$H_3\,c_1^4 = H'_4\,c_2^5$.	$H_3\,c_2^3 = H'_4\,c_1^4$.
4¼	3½	22	11	4¼	6¼	15	30	4¼	56	61	22	4¼	2¾	3	94	22	47	38
5	3¾	24	12	5	7	17	34	5	62	68	24	5	2¾	3½	105	24	52	42
5¼	4	26	13	5¼	8	18	37	5¼	68	75	26	5¼	3	3¼	116	26	58	47
6	4¼	29	14	6	9	20	40	6	74	82	29	6	3¼	4	126	29	63	51
6¼	4¾	31	16	6¼	9	21	44	6¼	81	88	31	6¼	3¾	4¼	136	31	68	55
7	5	33	17	7	10	23	47	7	87	95	33	7	4	4¼	147	33	73	59
7¼	5½	36	18	7¼	11	25	50	7¼	93	102	36	7¼	4	5	157	36	79	63
8	6	38	19	8	11	27	54	8	99	109	38	8	4½	5¼	167	38	84	68
9	6¾	43	21	9	13	30	61	9	112	123	43	9	5	6	188	43	94	76

TABLE VII.—1 FT. 11½ IN. GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 3⅛ inches.
Clearance at point of fast point = 2 "
Thickness at point of fast point = ⅛ inch.

JUNCTIONS. Fig. 1, Plate I.

$c_1^2 = c_2^4$.	$c_1^2 = c_3^4$.	c_1^4.	c_2^3.	$H_3\, c_1^2 = H_4\, c_2^4$.	$H_3\, c_1^2 = H_4\, c_3^4$.	$H_4\, c_1^4$.	$H_4\, c_2^3$.	c	$H_4\, c$
4	2½	2	2½	11	25	29	20	2	7
4½	2½	2½	3	12	28	33	22	2½	31
5	2⅝	2½	3½	13	31	37	25	2½	34
5½	3	2⅝	3½	15	34	40	27	2⅝	37
6	3½	3	4	16	38	44	30	3	41
6½	3½	3	4½	17	41	48	32	3½	44
7	4	3½	4½	18	44	51	35	3½	48
7½	4	3½	5	20	47	55	37	3½	51
8	4½	4	5½	21	50	59	40	4	54
9	5	4½	6	24	56	66	44	4½	61
10	5½	5	6½	26	63	73	49	5	68
11	6	5½	7	29	69	81	54	5½	75
12	6½	6	8	32	75	88	59	6	82
13	7	6½	9	34	81	95	64	6½	88
14	7½	6½	9	37	88	103	69	7	95
15	8	7	10	39	94	110	74	7½	102
16	9	7½	10	42	100	118	79	8	109

If R = radius of main line in chains.
r = radius of branch line in chains.

$c_1^2 = 4\sqrt{r}$ when the main line is straight.

$c_1^2 = 4\sqrt{\frac{Rr}{R-r}}$ when the main line is curved and the branch road curves in the same direction.

$c_1^2 = 4\sqrt{\frac{Rr}{R+r}}$ when the main line is curved and the branch roads curve in opposite directions.

Length of splay of fast point = ½ × c_1^2 feet.

Distance of point from point of crossing = 3 × c_1^2 feet.

A cross-over cannot be put in when the radius of the main line is less than 2 chains, or a through road when the radius is less than 2½ chains. The greatest and least values of c_1^2 for cross-over and through roads are—

Least value = $4\sqrt{\frac{R}{R-1}}$.

Greatest value = $4\sqrt{R}$.

THREE THROWS.

Branch Roads Curving in opposite Directions. Fig. 2, Plate I.				Branch Roads Curving in the same Direction. Fig. 3, Plate I.			
$c_{r_1} = c_{r_2}$.	c_{rs}.	$H_1\, c_{r_1} = H_2\, c_{r_2}$.	$H_1\, c_{rs} = H_2\, c_{rs}$.	c_{r_2}.	$c_{r_1} = c_{rs}$.	$H_2\, c_{r_2}$.	$H_2\, c_{r_1} = H_2\, c_{rs}$.
4	3	11	6	4	6	8	15
4½	3½	12	6	4½	6½	9	17
5	3½	13	7	5	7	10	19
5½	4	15	8	5½	8	11	20
6	4½	16	8	6	9	12	22
6½	4½	17	9	6½	9	13	24
7	5	19	10	7	10	14	26
7½	5½	20	10	7½	11	15	28
8	6	21	11	8	11	16	30

CROSS-OVER. Fig. 4, Plate I.

$c_1^2 = c_2^3$.	Interval between heels of Switches.	$H_2\, c_1^2 = H'_2\, c_2^3$.
4	32	11
4½	35	12
5	39	13
5½	43	15
6	47	16
6½	51	17
7	55	19
7½	59	20
8	63	21

THROUGH ROADS. Fig. 5, Plate V.

$c_1^2 = c_2^3$.	$c_1^2 = c_2^4$.	$c_1^4 = c_2^3$.	Interval between heels of Switches.	$H_2\, c_1^2 = H'_2\, c_2^3$.	$H_2\, c_1^2 = H'_2\, c_2^4$.	$H_2\, c_2^3 = H'_2\, c_1^4$.
4	2½	2⅝	50	11	25	20
4½	2½	3	56	12	28	22
5	2⅝	3½	62	13	31	25
5½	3	3½	68	15	34	27
6	3½	4	76	16	38	30
6½	3½	4½	82	17	41	32
7	4	4½	88	18	44	35
7½	4	5	94	20	47	37
8	4½	5½	100	21	50	40

Fig. 1.

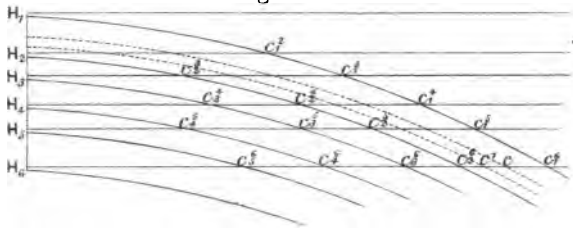


Fig. 2.

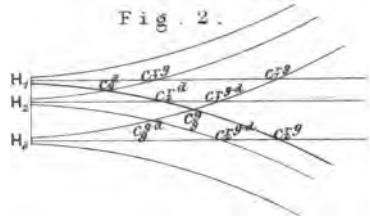


Fig. 3.

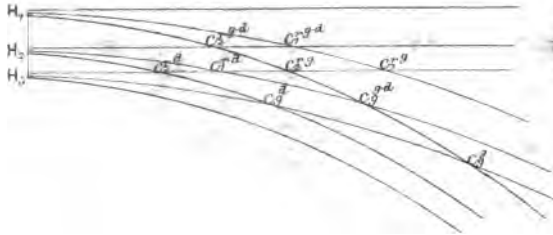


Fig. 4.

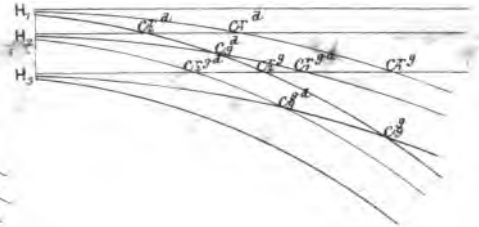


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TABLE VIII.—7 FT. AND 4 FT. 8½ IN. MIXED GAUGE.

Sum of clearance at heel of switch and thickness of top flange = 4¼ inches.
Clearance at point of fast point = 2 "
Thickness of point of fast point = ⅛ inch.

| JUNCTIONS. Fig. 1, Plate II. | | |

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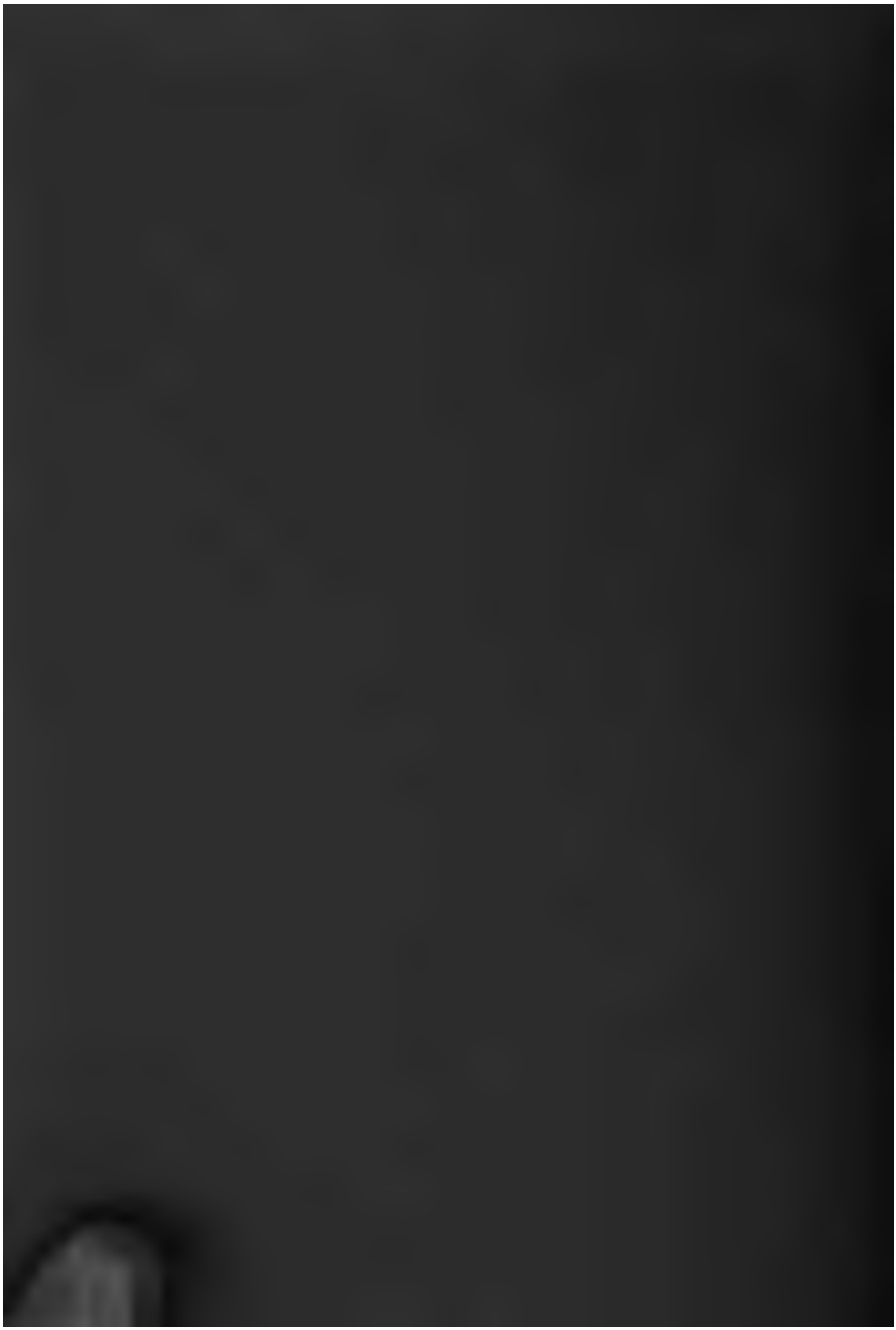
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